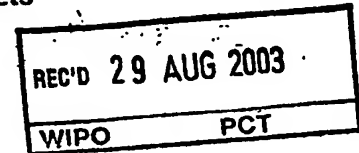




Europäisches  
Patentamt

European  
Patent Office

Office européen  
des brevets



18 JAN 2005  
PCT/EP 03/08061  
#2

Bescheinigung

Certificate

Attestation

Die angehefteten Unterla-  
gen stimmen mit der  
ursprünglich eingereichten  
Fassung der auf dem näch-  
sten Blatt bezeichneten  
europäischen Patentanmel-  
dung überein.

The attached documents  
are exact copies of the  
European patent application  
described on the following  
page, as originally filed.

Les documents fixés à  
cette attestation sont  
conformes à la version  
initialement déposée de  
la demande de brevet  
européen spécifiée à la  
page suivante.

Patentanmeldung Nr. Patent application No. Demande de brevet n°

02016091.7

**PRIORITY  
DOCUMENT**  
SUBMITTED OR TRANSMITTED IN  
COMPLIANCE WITH RULE 17.1(a) OR (b)

Der Präsident des Europäischen Patentamts;  
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets  
p.o.

R C van Dijk

BEST AVAILABLE COPY



Anmeldung Nr:  
Application no.: 02016091.7  
Demande no:

Anmeldetag:  
Date of filing: 19.07.02  
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

SHELL INTERNATIONALE RESEARCH  
MAATSCHAPPIJ B.V.  
Carel van Bylandtlaan 30  
2596 HR Den Haag  
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:  
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.  
If no title is shown please refer to the description.  
Si aucun titre n'est indiqué se référer à la description.)

Use of a yellow flame burner

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s)  
revendiquée(s)  
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/  
Classification internationale des brevets:

C10G/

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of  
filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR

19. Juli 2002

TS 8577 EPC

Crw

## USE OF A YELLOW FLAME BURNER

The invention is directed to an improved use of a yellow flame burner.

Conventional designs of oil burner assemblies for home heating fuel oils employ a traditional fuel/air mixing process in which the evaporation and combustion of the fuel oil take place simultaneously. In one form of oil burner assembly for home heating fuel oils the fuel oil is sprayed as a hollow cone and air is weakly swirled along a path which is parallel to the axis of a burner blast tube and which passes into the hollow cone so that the trajectories of the fuel oil droplets cross the air flow streamlines. This leads to a rapid evaporation giving fuel oil rich regions, which in turn ignite under local sub-stoichiometric conditions producing soot, and results in air pollution as well as a waste of a fossil fuel.

The general pattern of the flame of such an oil burner assembly is one of heterogeneity in terms of fuel concentrations; the pockets of fuel lean mixture give rise to high nitric oxide concentrations from both the fuel nitrogen and the atmospheric nitrogen, while the pockets of fuel rich mixture give rise to soot. The visible flame when using an Industrial Gas Oil fuel from such a system is yellow. The yellow colour is the visible radiation from the high temperature soot particles and this completely masks other visible radiations as far as the human eye is concerned. These soot particles result from non-burnt carbon.

For complete combustion of the carbon, that is soot-free combustion, the step-wise combustion of carbon to carbon dioxide via the intermediate carbon monoxide stage gives rise to a visible radiation in the blue region of the light spectrum. When this occurs the blue radiation becomes visible in a soot-free or low-luminosity flame, and oil burners for such soot-free flames are known as blue flame burners.

Blue flame burners are known to have a desirable low NOx emission as compared to yellow flame burners. Nevertheless yellow flame burners are still widely applied and there is thus a need to reduce the NOx of such yellow flame burners.

This object is achieved by the following use. Use of a Fischer-Tropsch derived fuel in a yellow flame burner.

Applicants have found that the low NOx emissions of a yellow flame burner can be reduced when a Fischer-Tropsch derived fuel is used. Applicants have even found that the NOx emission can be reduced to below the level of a blue flame burner using conventional Industrial Gas Oil as fuel. An even further advantage is that the carbon monoxide emission is reduced. A next advantage is that less odour during start and extinction of the yellow flame burner has been observed when using this fuel. This is very advantageous, especially when such a burner is used in a domestic environment, wherein frequent start and stops of the burner are common. A next advantage is that the carbon monoxide and hydrocarbon emissions at the cold or hot start of the yellow flame burner are less as compared to when state of the art oil is used. This is also very advantageous when the burner is used in for example a domestic heating application wherein frequently the burner has to start and stop.

Figure 1 shows a schematic representation of such a yellow flame burner.

Figure 1 shows a yellow flame burner 1 having pumping means 2 to supply a liquid fuel and a van 3 to supply an oxygen containing gas. The oxygen containing gas is usually air. The fuel is dispersed in a nozzle 4 and mixed with the air to form a combustible mixture, which is fed to a combustion space 5 via a conical shaped nozzle 6. Figure 1 also shows means 7 to ignite the mixture.

The operating conditions of the yellow flame burner may be the same as the operating conditions used for the state of the art fuels. The proportion of air in excess of that required for stoichiometric combustion is known as the excess air ratio or " $\lambda$ ", which is defined as the ratio of total air available for combustion to that required to burn all of the fuel. Preferably the  $\lambda$  is between 1 and 2 and more preferably between 1 and 1.6. Applicants found that by using a Fischer-Tropsch derived fuel a very low  $\lambda$  of between 1.05 and 1.2 could be applied without large emissions of carbon monoxide as would be the case when Industrial Gas Oil would be used.

The yellow flame burner using the Fischer-Tropsch fuels is preferably applied for domestic heating, wherein the heat of combustion is used to heat water by indirect heat exchange in so-called boilers. The heated water may be used to warm up the house or consumed in for example showers and the like. More preferably the yellow-flame burner is used in (domestic) application wherein more than 3 starts of the burner per hour takes place. The use of the present invention is especially suited for such applications because low hydrocarbon and carbon monoxide

emissions have been found at the start of the burner running on the Fischer-Tropsch derived fuel.

5 The yellow flame burner using the Fischer-Tropsch fuels may advantageously be further used for direct heating of large spaces. Such applications are characterized in that the flue gasses are directly supplied to said space to heat up said space. Spaces such as tents and halls are often heated up with such an apparatus. Normally gaseous fuels for example natural  
10 gas, LPG and the like, are used for this application because the associated flue gasses can be safely supplied to said space. A disadvantage of the use of gaseous fuels is however that handling of the pressurized gas containers and combustion equipment requires professional skills in order to operate such an apparatus safely.  
15 By using a Fischer-Tropsch derived liquid fuel a comparable flue gas is obtained in the yellow flame burner as when a gaseous fuel is used. Thus a method is provided wherein a liquid fuel can be applied for direct heating of spaces. The application of the liquid Fischer-Tropsch derived fuel makes the use of the apparatus for  
20 direct heating much more simple and safe.

25 The Fischer-Tropsch derived fuel may be any fraction of the middle distillate fuel range, which can be isolated from the (hydrocracked) Fischer-Tropsch synthesis product. Typical fractions will boil in the naphtha, kerosene or gas oil range. Preferably a Fischer-Tropsch fuel boiling in the kerosene or gas oil range is used as fuel for the present invention because these  
30 fractions are easier to handle in for example domestic environments. Such fuels will suitably comprise a fraction larger than 90 wt% which boils between 160 and 400 °C, preferably to about 370 °C.

Examples of Fischer-Tropsch derived kerosene and gas oils are described in EP-A-583836, WO-A-9714768, WO-A-9714769, WO-A-011116, WO-A-011117, WO-A-0183406, WO-A-0183648, WO-A-0183647, WO-A-0183641, WO-A-0020535, WO-A-0020534, EP-A-1101813, US-A-5766274, US-A-5378348, US-A-5888376 and US-A-6204426.

The Fischer-Tropsch derived fuel will suitably contain more than 80 wt% iso and normal paraffins and less than 1 wt% aromatics, the balance being naphthenics compounds. The content of sulphur and nitrogen will be very low and normally below the detection limits for such compounds. This low content of these elements is due to the specific process wherein the Fischer-Tropsch reaction is performed. The content of sulphur will therefore be below 5 ppm and the content of nitrogen will be below 1 ppm. As a result of the low contents of aromatics and naphthenics compounds the density of the Fischer-Tropsch product will be lower than the conventional mineral derived fuels. The density will be between 0.65 and 0.8 g/cm<sup>3</sup> at 15 °C.

The fuel used in the process of the present invention may also comprise other than Fischer-Tropsch derived fuel components. Examples of such components may be the kerosene or gas oil fractions as obtained in traditional refinery processes, which upgrade crude petroleum feedstock to useful products. Preferred non-Fischer-Tropsch fuel components are the ultra low sulphur (e.g. less than 50 ppm sulphur) kerosene or diesel fractions, which are currently on the market. Optionally non-mineral oil based fuels, such as bio-fuels, may also be present in the fuel composition. The content of the Fischer-Tropsch derived fuel component in the fuel will be preferably be above 40 wt%, more

preferably above 60 wt% and most preferably above 80 wt%. It should be understood that the content of such, currently less available, Fischer-Tropsch derived fuels will be optimised, wherein pricing of the total fuel will be balanced with the advantages of the present invention. For some applications fuels fully based on a Fischer-Tropsch derived fuel plus optionally some additives may be advantageously used.

Yellow flame burners are often provided with a flame detector. Most detectors, which are used today, detect a particular wavelength associated with the yellow colour of the flame. Applicants have now found that when a Fischer-Tropsch derived fuel is used the commonly known detectors fail to observe the resulting blue coloured flame. For this reason the yellow flame burner is preferably provided with a detector, which can detect this blue flame. Examples of suitable detectors are the detectors that are used in blue flame burners. Alternatively additives may be added to the Fischer-Tropsch derived fuel which result in a flame which can be detected by the above standard yellow flame burner detector.

The fuel may also comprise one or more of the following additives. Detergents, for example OMA 350 as obtained from Octel OY; stabilizers, for example Keroxon ES 3500 as obtained from BASF Aktiengesellschaft, FOA 528A as obtained from OCTEL OY; metal-deactivators, for example IRGAMET 30 (as obtained from Speciality Chemicals Inc; (ashless) dispersants, for example as included in the FOA 528 A package as obtained from Octel OY; anti-oxidants; IRGANOX L57 as obtained from Specialtiy Chemicals Inc; cold flow improvers, for example Keroflux 3283 as obtained from BASF Aktiengesellschaft,



R433 or R474 as obtained from Infineum UK Ltd; combustion improver, for example ferrocene, methylcyclopentadienylmanganese-tricarbonyl (MMT); anti-corrosion: Additin RC 4801 as obtained from Rhein Chemie GmbH, Kerocorr 3232 as obtained from BASF, SARKOSYL 0 as obtained from Ciba; re-odorants, for example Compensol as obtained from Haarmann & Reiner; biocides, for example GROTA MAR 71 as obtained from Schuelke & Mayr; lubricity enhancers, for example OLI 9000 as obtained from Octel; dehazers, for example T-9318 from Petrolite; antistatic agents, for example Stadis 450 from Octel; and foam reducers, for example TEGO 2079 from Goldschmidt.

The Fischer-Tropsch derived fuel is colourless and odourless. For safety reasons an odour marker, as for example applied in natural gas for domestic consumption, may be present in the Fischer-Tropsch derived fuel. Also a colour marker may be present to distinguish the fuel from other non-Fischer-Tropsch derived fuels.

The total content of the additives may be suitably between 0 and 1 wt% and preferably below 0.5 wt%.

The invention will now be illustrated with the following non-limiting examples.

#### Example 1

To a yellow flame burner of Type 800 ULV-S (Shell Direct GmbH) as placed in a PKR-140 boiler (Oertel Rohleder Wearmettechnik GmbH) a Fischer-Tropsch derived kerosene (Oil A), a Fischer-Tropsch gas oil (Oil B), an ultra low sulphur gas oil (Oil C) and a standard industrial gas oil (Oil D) having the properties as listed in Table 1 was fed at different lambda. The oils contained the same standard additive package.

Table 1

	Fischer-Tropsch kerosene (A)	Fischer-Tropsch gas oil (B)	Reference oil-1 (C)	Reference oil-2 (D)
Density (at 15 °C in kg/m <sup>3</sup> )	734.8	785.2	854.3	846.3
Sulphur content (wt%)		< 0.0001	0.142	0.061
Kinematic viscosity at 20 °C (mm <sup>2</sup> /s).	1.246	6.444	3.842	4.621
Flash point (°C)	43	92	64	66

During the experiment the NO<sub>x</sub> content was measured by chemoluminescence. In Figure 2 the NO<sub>x</sub> emission relative to the energy is shown at different Lambda values for the fuels A-D. The energy in kWh is calculated from the amount of fuel fed to the burner and its caloric value. It is clear that the NO<sub>x</sub> emissions are lower for the Fischer-Tropsch derived fuels as compared to when a normal gas oil or an ultra low sulphur gas oil is used.

The carbon monoxide emission was also measured. In Figure 3 the CO emission relative to the energy is presented for different values of lambda for oils A-D.

#### Example 2

To a blue flame burner of type Gulliver BLU BGI (Riello) as placed in a Vitola 200 Boiler (Viessmann Werke GmbH&Co) a conventional gas oil D was supplied.

The NOx emissions and power were measured at different lambda. The NOx values were found to be larger than 140 mg/kWh. These values are higher than when using a yellow flame burner and the Fischer-Tropsch derived fuel as illustrated in Figure 2.

Example 3

Example 1 was repeated for oils A, B and C. The hydrocarbon and carbon monoxide emissions were measured at a warm start up. With a warm start up is here meant that the boiler temperature was kept constant at its operating temperature.. In Figures 4 and 5 the carbon monoxide and hydrocarbon emissions are shown as a function of time. It can be observed that both the CO and hydrocarbon emissions are less when a Fischer-Tropsch derived fuel is used when compared to when conventional gas oil is used.

19. Juli 2002

TS 8577 EPC

C L A I M S

1. Use of a Fischer-Tropsch derived fuel in a yellow flame burner.
2. Use according to claim 1, wherein the lambda is between 1 and 1.6
- 5 3. Use according to claim 2, wherein the lambda is between 1.05 and 1.2.
4. Use according to any one of claims 1-3, wherein the flue gases as obtained by said use are used to heat water by means of indirect heat exchange in a boiler.
- 10 5. Use according to any one of claims 1-3, wherein the flue gases as obtained by said use are used to directly heat a space.
6. Use according to any one of claims 1-5, wherein the Fischer-Tropsch derived fuel boils for more than 90 wt%  
15 between 160 and 400 °C.
7. Use according to claim 6, wherein the Fischer-Tropsch derived fuel boils for more than 90 wt%  
between 160 and 370 °C.
8. Use according to any one of claims 1-7, wherein the Fischer-Tropsch derived fuel contains more than 80 wt%  
20 of iso and normal paraffins, less than 1 wt% aromatics, less than 5 ppm sulphur and less than 1 ppm nitrogen and wherein the density of the Fischer-Tropsch derived fuel is between 0.65 and 0.8 g/cm<sup>3</sup> at 15 °C.
9. Use according to any one of claims 1-8, wherein the Fischer-Tropsch derived fuel comprises more than 80 wt%  
25 of a Fischer-Tropsch product.
10. Use according to claim 9, wherein the Fischer-Tropsch derived fuel comprises a mineral oil fraction and/or a  
30 non-mineral oil fraction.

11. Use according to any one of claims 1-10, wherein more than 3 starts per hour are made with the yellow flame burner.

5 12. Use according to any one of claims 1-11, wherein the Fischer-Tropsch derived fuel comprises one or more additives.

13. Use according to claim 12, wherein the Fischer-Tropsch derived fuel comprises an odour marker.

10 14. Use according to any one of claims 12-13, wherein the Fischer-Tropsch derived fuel comprises a colour marker.

15. Use according to any one of claims 12-14, wherein an additive is present which changes the colour of the flame such that is detectable by a yellow flame detector.

16. Use according to any one of claim 1-14, wherein a blue flame detector is used to detect the yellow flame burner flame.

19. Juli 2002

- 12 -

TS 8577 EPC

A B S T R A C T

USE OF A YELLOW FLAME BURNER

Use of a Fischer-Tropsch derived fuel in a yellow flame burner.

Use according to any one of claims 1-7, wherein the Fischer-Tropsch derived fuel contains more than 80 wt% of iso and normal paraffins, less than 1wt% aromatics, less than 5 ppm sulphur and less than 1 ppm nitrogen and wherein the density of the Fischer-Tropsch derived fuel is between 0.65 and 0.8 g/cm<sup>3</sup> at 15 °C.

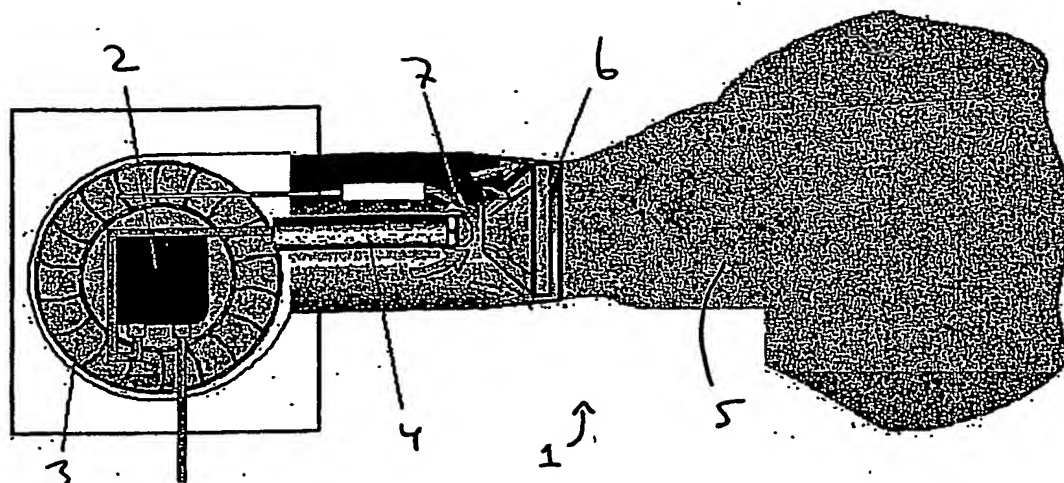


Fig. 1

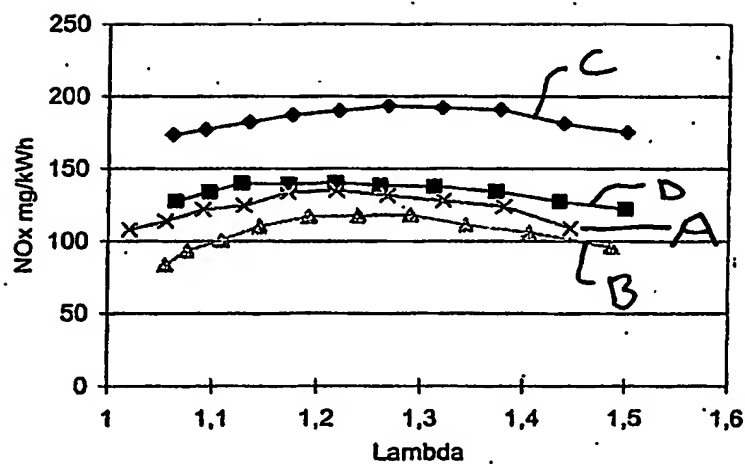


Fig. 2

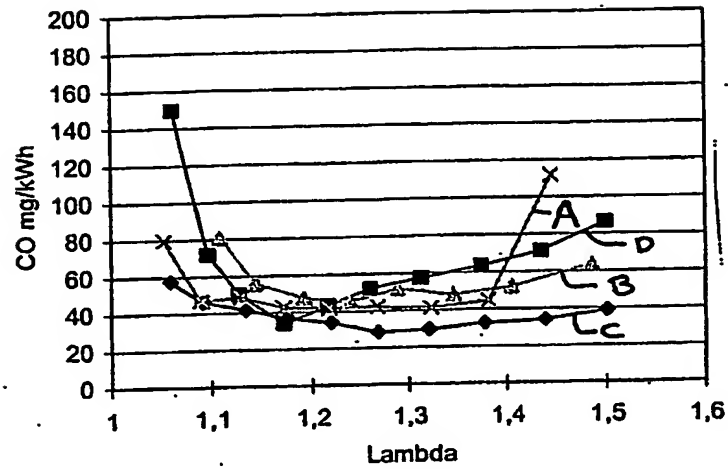


Fig. 3

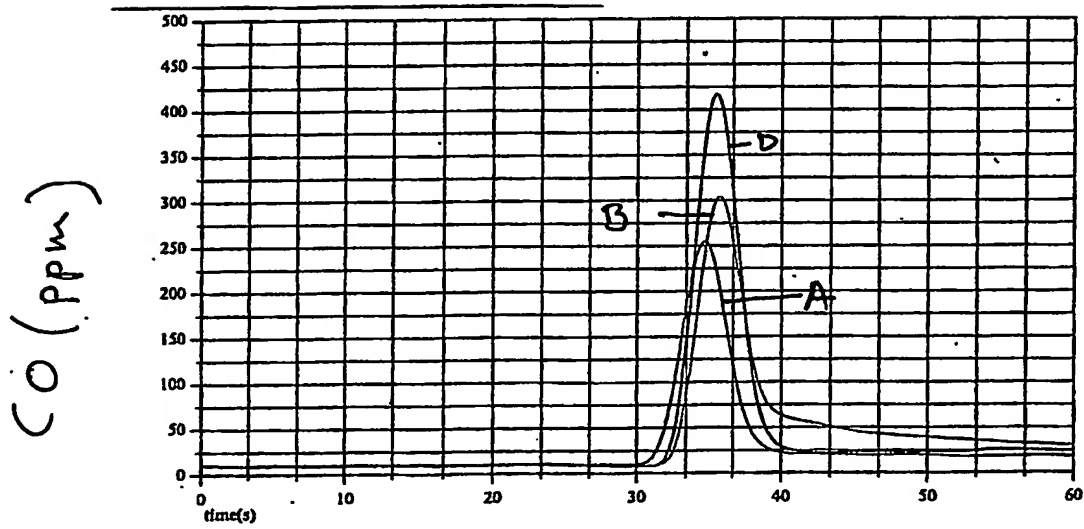


Fig. 4



**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☒ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**